# United States Patent

**Cheffers et al.**

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## [54] BREATHING APPARATUS


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[51] **Int. Cl.** ..... **A61m 16/00**

[58] **Field of Search** ..... 128/147, 142.2, 142.3, 146.3, 128/146.4, 145, 145 A, 142, 142.4, 212



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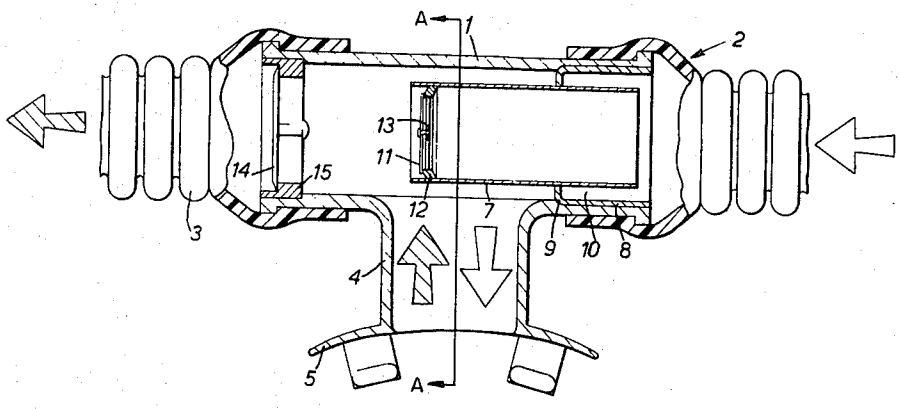
[57] **ABSTRACT**

In breathing apparatus, inhalation valve means, which allows gas to be inhaled from an inhalation conduit, is situated directly within the path of flow of the exhaled gas so that, in operation, heat is transferred from the exhaled gas to the inhalation valve means. The flow of warm, exhaled gas over the inhalation valve means raises the temperature of the valve means and reduces the likelihood of ice formation.


**1 Claim, 3 Drawing Figures**



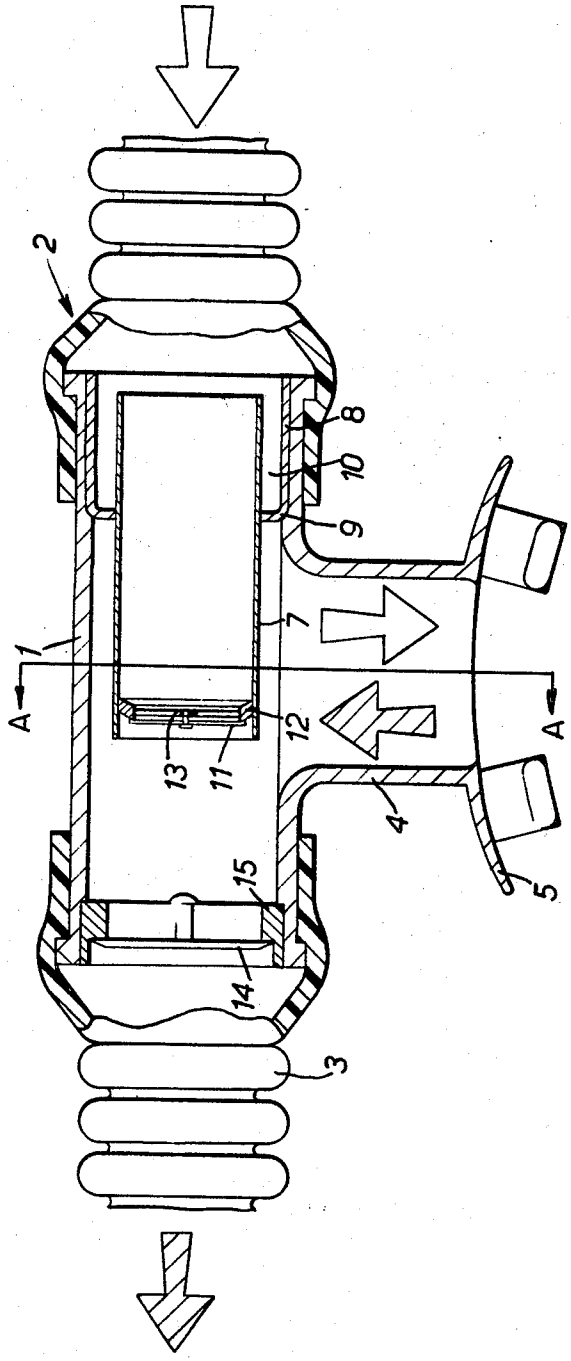



FIG. 1.

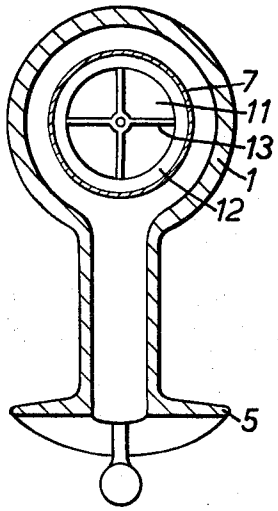



FIG. 2.

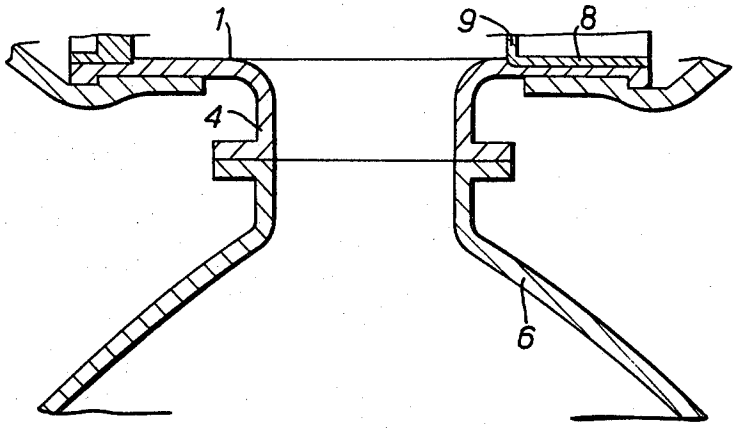



FIG. 3.

# BREATHING APPARATUS

The invention relates to breathing apparatus and especially to closed-circuit breathing apparatus.

In closed-circuit breathing apparatus, the circuit includes an inhalation conduit through which gas may be inhaled and an exhalation conduit through which the exhaled gases may pass. Carbon dioxide is removed from the exhaled gases which are then subsequently recirculated to the inhalation conduit. Non-return valves are used in both the inhalation and exhalation conduits to ensure that gas circulates in the correct direction. In open-circuit breathing apparatus, on the other hand, the exhaled gases are discharged.

Problems arise when such breathing apparatus is used in an environment that is at a low temperature (of the order of 5°C. and below), for example, when the apparatus is used under water, because the exhaled gases contain a substantial quantity of water vapor. In such environments the temperature of the gas passing through the inhalation conduit is often cold enough to freeze any water which may have condensed around the inhalation non-return valve, impairing the performance of the valve and the functioning of the apparatus as a whole.

The problem arises especially when liquid oxygen is used as the source of oxygen, for the gas to be inhaled is then often at a lower temperature than the ambient temperature. The problem may also occur, however, when compressed gas is used even though this may be at a higher temperature than that of the surroundings, if the ambient temperature itself is very low.

This invention provides breathing apparatus which comprises a chamber having a user's conduit through which a user can inhale gas from the chamber and exhale gas into the chamber, an inhalation conduit, an exhalation conduit, the interior of the inhalation and exhalation conduits being in communication with the interior of the chamber and a portion of the inhalation conduit extending inside the chamber, inhalation valve means arranged to allow gas to enter the chamber on inhalation by a user through the user's conduit and exhalation valve means arranged to allow gas to leave the chamber through the exhalation conduit on exhalation by the user through the user's conduit, the inhalation valve means being situated in the portion of the inhalation conduit within the chamber and directly opposite to the user's conduit in the path of flow of the exhaled gas from the user's conduit, whereby, in use, heat is transferred from the exhaled gas to the inhalation valve means.

The flow of warm, exhaled gas directly over the inhalation valve means raises the temperature of the valve means and reduces the likelihood of ice formation. Thus the invention enables the breathing apparatus to be used in environments that are at a relatively low temperature.

Further, water vapor contained in the exhaled gas tends to condense on the walls of the chamber. The condensed water and saliva (when the user respires through the mouth) collect in the chamber, and the risk of liquid passing through the inhalation valve to the inhalation conduit is decreased. The liquid collected in the chamber also acts as a source of heat, further reducing the tendency of ice formation on and around the inhalation valve means.

If a part of the portion of the inhalation conduit situated within the chamber is also within the path of flow of the exhaled gas, the tendency of ice formation on the interior of that part of the conduit can also be reduced.

Ice, which may be formed inside the inhalation conduit due, for example, to washing out the apparatus before use, may become detached from the wall of the conduit during use. This ice may slide towards the inhalation valve means and, unless checked, aggravate the freezing problem at the valve. Advantageously, therefore, a trapping chamber of annular cross-section is located around the inhalation conduit and the inhalation conduit is in communication with the interior of the trapping chamber through a circumferentially-extending opening in the wall of the conduit, at least a portion of the trapping chamber being located around the portion of the inhalation conduit between the said opening and the inhalation valve means. This annular chamber acts as an ice trap and collects ice sliding along the wall of the inhalation conduit towards the inhalation valve means.



Breathing apparatus constructed in accordance with the invention will now be described by way of example with reference to the accompanying drawings, in which:

FIG. 1 is a longitudinal section through the apparatus;

FIG. 2 is a section through the apparatus taken along the line A—A shown in FIG. 1; and

FIG. 3 is a section through a modified portion of the apparatus to enable a mask to be use in place of a mouth-piece.

Referring to the accompanying drawings, the apparatus comprises a cylindrical chamber 1 to one end of which is secured an inhalation conduit, indicated generally by the reference numeral 2, and to the other end of which is secured an exhalation conduit 3. The cylindrical chamber 1 is formed with a connecting pipe 4 which extends radially outwards from the chamber 1 and connects the interior of the chamber 1 with a user's conduit which may be a mouth-piece 5 or (as shown in FIG. 3) a mask 6.

Both the inhalation conduit 2 and the exhalation conduit 3 comprise a flexible tube secured to the chamber 1, but the inhalation conduit 2 also comprises a rigid cylindrical portion 7 located within the chamber 1 and extending co-axially with it. The portion 7 of the inhalation conduit 2 is secured to the interior of the wall of the chamber 1 by means of a sleeve 8 formed at one end with an inwardly extending annular flange 9 secured at its inner edge to the portion 7. The volume bounded by the sleeve 8 and the flange 9 and the portion 7 forms a trapping chamber 10 of annular cross-section that is open at the end remote from the exhalation conduit 3.

A non-return valve 11 is located within the portion 7 of the inhalation conduit 2 near the end farthest from the annular chamber 10. The valve 11 seats against a flange 12 in the portion 7 and, by movement towards the end of the portion 7 remote from the annular chamber 10, allows gas to pass from the interior of the conduit 2 to the chamber 1. A spider 13 limits movement of the valve 11 in the other direction (see FIG. 2). A similar valve 14 is situated near the end of the chamber 1 to which the exhalation conduit 3 is secured. A cylindrical member 15 attached to the interior surface of the wall of the chamber 1, is of decreased internal diameter towards the chamber 1 to form a shoulder on which the valve 14 seats. The valve 14 only allows gas to pass from the chamber 1 to the exhalation conduit 3 and not in the opposite direction.

In operation, when the wearer inhales, the inhalation valve 11 opens to allow gas to pass from the inhalation conduit 2 into the chamber 1. On exhalation, the inhalation valve 11 closes and the exhalation vale 14 opens. The gas exhaled by the wearer passes over the inhalation valve 11 and at least a part of the portion 7 of the inhalation conduit 2. The gas is relatively warm and will tend to melt any ice on the valve or interior of the portion 7 and to prevent ice from forming.

Any ice that may form on the interior wall of the inhalation conduit 2 and become detached from the wall by flexing of the conduit during use will tend to be collected in the annular chamber 10 surrounding the portion 7 of the conduit 2.

We claim:

1. Breathing apparatus which comprises a chamber having a user's conduit through which a user can inhale gas from the chamber and exhale gas into the chamber, an inhalation conduit, an exhalation conduit, the interior of the inhalation and exhalation conduits being in communication with the interior of the chamber and a portion of the inhalation conduit extending inside the chamber, inhalation valve means arranged to allow gas to enter the chamber on inhalation by a user through the user's conduit, exhalation valve means arranged to allow gas to leave the chamber through the exhalation conduit on exhalation by the user through the user's conduit, the inhalation valve means being situated in the portion of the inhalation conduit within the chamber and directly opposite to the user's

conduit, whereby, in use, heat is transferred from the exhaled gas to the inhalation valve means and a trapping chamber of annular cross-section located around the inhalation conduit, the inhalation conduit being in communication with the interior of the trapping chamber through a circumferentially-extending opening in the wall of the conduit, and at least a portion of the trapping chamber being located around the portion of the inhalation conduit between the said opening and the inhalation valve means.



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